James A. Storer

Professor of Computer Science

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Education:

Ph.D. Princeton University, computer science (1979)
M.A. Princeton University, computer science (1977)
B.A. Cornell University, mathematics and computer science (1975)

Employment History:

Brandeis University, Professor of Computer Science (1993 - present)
Brandeis University, Associate Professor of Computer Science (1986 - 1992)
Harvard University, Visiting Professor of Computer Science (1987 - 1988)
Brandeis University, Assistant Professor of Computer Science (1981 - 1986)
Bell Laboratories at Murray Hill, MTS (1979 - 1981)

Research Interests:

Computer algorithms, image retrieval, data compression and archiving (including text, images, video, and multi-media), data similarity measures, pattern matching, data communications, processing of large data sets (including hyperspectral imagery), text, image, and video processing, parallel computing, machine learning.

Professional Activities:

- In 1991 I founded the Annual IEEE Data Compression Conference (DCC), the first major international conference devoted entirely to data compression, and have served as the conference chair since then.

- I am a member of the ACM and IEEE Computer Society. I routinely serve as referee for papers submitted to journals (JACM, SICOMP, Theoretical CS, J. Algorithms, Algorithms, *Signal Processing*, JPDC, Acta Inf., Algorithmicia, IPL, IPM, Theoretical CS, J. Alg., Networks, IEEE J. Rob. & Aut., IEEE Trans. Inf. Theory, IEEE Trans. Comp., IEEE Trans. Image Proc., Proceedings of the IEEE, IBM J. of R&D, JCSS, etc.). I have served as an editor for *Information Processing and Management, Journal of Visual Communication and Image Representation*, and the *Proceedings of the IEEE*. I have served as a program committee member for various conferences, including *IEEE Data Compression Conference*, *Combinatorial Pattern Matching* (CPM), *International Conference on String Processing and Information Retrieval* (SPIRE), *Conference on Information and Knowledge Management* (CIKM), *Sequences* and *Combinatorial Algorithms on Words*, *DAGS*.

- I consult in the areas of computer algorithms, data compression and communicaions (including text, image, and video), data storage and backup, cell phone, digital camera, and DVR technology, image and video processing, information and image retrieval, including providing expert services for computing technology related litigation.

- I have obtained patents and SBIR funding to engage in research projects (such as high speed data compression hardware) that were not possible within the university environment, but which complemented my academic research and provided practical experience on which to base research directions.

Books

Hyperspectal Data Compression

G. Motta, F. Rizzo, and J. A. Storer, Editors
Springer-Verlag, www.springer.com, November 2006
(425 pages, 6" x 9", hard-bound)
ISBN: 0-387-28579-2

This book provides a survey of recent results in the field of compression of remote sensed 3D data, with a particular interest in hyperspectral imagery. This material is intended to be of interest to researchers in a variety of areas, including multi dimensional data compression, remote sensing, military and aerospace image processing, homeland security, archival of large volumes of scientific and medical data, target detection, and image classification.

The interest in remote sensing applications and platforms (including airborne and spaceborne) has grown dramatically in recent years. Remote sensing technology has shifted from panchromatic data (a wide range of wavelengths merged into a single response), through multispectral (a few possibly overlapping bands in the visible and infrared range with spectral width of 100-200nm each), to hyperspectral imagers and ultraspectral sounders, with hundreds or thousands of bands. In addition, the availability of airborne and spaceborne sensors has increased considerably, followed by the widespread availability of remote sensed data in different research environments, including defense, academic, and commercial.

Remote sensed data present special challenges in the acquisition, transmission, analysis, and storage process. Perhaps most significant is the information extraction process. In most cases accurate analysis depends on high quality data, which comes with a price tag: increased data volume. For example, the NASA JPL's *Airborne Visible/Infrared Imaging Spectrometer* (AVIRIS, http://aviris.jpl.nasa.gov) records the visible and the near-infrared spectrum of the reflected light of an area 2 to 12 kilometers wide and several kilometers long (depending on the duration of the flight) into hundreds of non overlapping bands. The resulting data volume typically exceeds 500 Megabytes per flight and it is mainly used for geological mapping, target recognition, and anomaly detection. On the other hand, ultraspectral sounders such as the NASA JPL's *Atmospheric Infrared Sounder* (AIRS, http://www-airs.jpl.nasa.gov), which has recently become a reference in compression studies on this class of data, records thousands of bands covering the infrared spectrum and generates more than 12 Gigabytes of data daily. The major application of this sensor is the acquisition of atmospheric parameters such as temperature, moisture, clouds, gasses, dust concentrations, and other quantities to perform weather and climate forecast.

Chapter 1 addresses compression architecture and reviews and compares compression methods. Chapter 2 through 4 focus on lossless compression (where the decompressed image must be bit for bit identical to the original). Chapter 5 (contributed by the editors) describes a lossless algorithm based on vector quantization with extensions to near lossless and possibly lossy compression for efficient browsing and pure pixel classification. Chapters 6 deals with near lossless compression while Chapter 7 considers lossy techniques constrained by almost perfect classification. Chapters 8 through 12 address lossy compression of hyperspectral imagery, where there is a tradeoff between compression achieved and the quality of the decompressed image. Chapter 13 examines artifacts that can arise from lossy compression.

An Introduction to Data Structures and Algorithms

James A. Storer
Birkhäuser / Springer, www.springer.com, February 2002
(600 pages, 7" x 10", hard-bound)
ISBN 0-8176-4253-6, ISBN 3-7643-4253-6

A highly a highly accessible format presents algorithms with one page displays that will appeal to both students and teachers of computer science. The thirteen chapters include: Models of Computation (including Big O notation), Lists (including stacks, queues, and linked lists), Induction and Recursion, Trees (including self-adjusting binary search trees), Algorithms Design Techniques, Hashing, Heaps (including heapsort and lower bounds on sorting by comparisons), Balanced Trees (including 2-3 trees, red-black trees, and AVL trees), Sets Over a Small Universe (including on-the-fly array initialization, in-place permutation, bucket sorting, bit-vectors, and the union-find data structure), Discrete Fourier Transform (including an introduction to complex numbers, development of the FFT algorithm, convolutions, the DFT on an array of reals, the discrete cosine transform, computing the DCT with a DFT of n/2 points, 2D DFT and DCT, and an overview of JPEG image compression), Strings (including lexicographic sorting, KMP / BM / Rabin-Karp / Shift-And string matching, regular expression pattern matching, tries, suffix tries, edit distance, Burrows-Wheeler transform, text compression examples), Graphs (including DFS / BFS, biconnected and strongly connected components, spanning trees, topological sort, Euler paths, shortest paths, transitive closure, path finding, flow, matching, stable marriage, NP-complete graph problems), Parallel Models of Computation (including the PRAM, generic PRAM simulation, the hypercube/CCC/butterfly, the mesh, and hardware area-time tradeoffs).

- Concepts are expressed clearly, in a single page, with the least amount of notation, and without the "clutter" of the syntax of a particular programming language; algorithms are presented with self-explanatory "pseudo-code".

- Each chapter starts with an introduction and ends with chapter notes and exercises that promote further learning.

- Sorting, often perceived as rather technical, is not treated as a separate chapter, but is used in many examples (including bubble sort, merge sort, tree sort, heap sort, quick sort, and several parallel algorithms). Lower bounds on sorting by comparisons are included with the presentation of heaps in the context of lower bounds for comparison based structures.

- Chapters 1-4 focus on elementary concepts, the exposition unfolding at a slower pace. Sample exercises with solutions are also provided. These chapters assume a reader with only some basic mathematics and a little computer programming experience. An introductory college-level course on data structures may be based on Chapters 1 -4 and the first half of Chapters 5 (algorithms design), 6 (hashing), and 12 (graphs).

- Chapters 5-13 progress at a faster pace. The material is suitable for undergraduates or graduates who need only review Chapters 1-4. A more advanced course on the design and analysis of algorithms may be based on these chapters.

- Chapter 13 on parallel models of computation is something of mini-book itself. The idea is to further teach fundamental concepts in the design of algorithms by exploring exciting models of computation, including the PRAM, generic PRAM simulation, HC/CCC/Butterfly, the mesh, and parallel hardware area-time tradeoffs (with many examples). A sampling of this chapter can be a fun way to end a course based on earlier portions of the book. In addition, a seminar style course can spends its first half covering this chapter in detail and then study papers from the literature.

- Apart from classroom use, this book serves as an excellent reference text on the subject of data structures, algorithms, and parallel algorithms. Its page-at-a-time format makes it easy to review material that the reader has studied in the past.

Data Compression: Methods and Theory

James A. Storer
Computer Science Press (a subsidiary of W. H. Freeman Press), 1988
(419 pages, 6" x 9", hard-bound)
ISBN 0-88175-161-8

The first two chapters contain introductory material on information and coding theory. The remaining four chapters cover some of my data compression research performed in the period 1977 - 1987 (including substantial material that has not been reported elsewhere). Chapter 3 considers on-line textual substitution methods that employ "learning" heuristics to adapt to changing data characteristics. Chapter 4 considers massively parallel algorithms for on-line methods and their VLSI implementations. Chapter 5 considers off-line methods (including the NP-completeness of certain methods). Chapter 6 addresses program size (Kolmogorov) complexity. The appendices present source code and empirical results.

Image and Text Compression

James A. Storer, Editor
Kluwer Academic Press (part of Springer), 1992
(354 pages, 6" x 9", hard-bound)
ISBN 0-7923-9243-4

This is an edited volume of papers by leading researchers in the field; topics include: vector quantization, fractals, optical algorithms, arithmetic coding, context modeling, LZ methods, massively parallel hardware (the chapter I contributed), bounds on Huffman codes, coding delay, and 2D lossless compression. Also included is a 75 page bibliography of data compression research that I compiled specifically for this book.

Proceedings Compression and Complexity

B. Carpentieri, A. De Santis, U. Vaccaro, and J. A. Storer, Editors
IEEE Computer Society Press, 1998
(400 pages, 6" x 9", hard-bound)
ISBN 0-8186-8132-2

This is an edited volume of the papers presented at the *International Conference on Compression and Complexity of Sequences*, held in Positano, Italy in 1997.

Papers address the theoretical aspects of data compression and its relationship to problems on sequences, and include contributions from the editors.

Proceedings of the Data Compression Conference

James A. Storer, Chair and co-editor
IEEE Computer Society Press
1991 - present (approximately 500 pages hard-bound)

The DCC proceedings are co-edited with the DCC program committee chair, which over the years has included J. Reif (1991), M. Cohn (1992-2006), and M. Marcellin (2007-present).

Each volume has ten page extended abstracts of the presentations at technical sessions and one page abstracts of presentations at the posters session. The call for papers states that topics of interest include but are not limited to:

An international forum for current work on data compression for text, images, video, audio, and related areas. Topics of interest include but are not limited to: Lossless and lossy compression algorithms for specific types of data (text, images, multi-spectral and hyper-spectral images, palette images, video, speech, music, maps, instrument and sensor data, space data, earth observation data, graphics, 3D representations, animation, bit-maps, etc.), source coding, text compression, joint source-channel coding, multiple description coding, quantization theory, vector quantization (VQ), multiple description VQ, compression algorithms that employ transforms (including DCT and wavelet transforms), bi-level image compression, gray scale and color image compression, video compression, movie compression, geometry compression, speech and audio compression, compression of multi-spectral and hyper-spectral data, compression of science, weather, and space data, source coding in multiple access networks, parallel compression algorithms and hardware, fractal based compression methods, error resilient compression, adaptive compression algorithms, string searching and manipulation used in compression applications, closest-match retrieval in compression applications, browsing and searching compressed data, content based retrieval employing compression methods, minimal length encoding and applications to learning, system issues relating to data compression (including error control, data security, indexing, and browsing), medical imagery storage and transmission, compression of web graphs and related data structures, compression applications and issues for computational biology, compression applications and issues for the internet, compression applications and issues for mobile computing, applications of compression to file distribution and software updates, applications of compression to files storage and backup systems, applications of compression to data mining, applications of compression to information retrieval, applications of compression to image retrieval, applications of compression and information theory to human-computer interaction (HCI), data compression standards including the JPEG, JPEG2000, MPEG (MPEG1, MPEG2, MPEG4, MPEG7, etc.), H.xxx, and G.xxx families.

Patents

Computational Modeling of Rotation and Translation Capable Human Visual Pattern Recognition

U.S. Provisional Patent Application No. 60/712,596
INVENTORS: John Lisman, James A. Storer, Martin Cohn, Antonella DiLillo
FILED: August 29, 2005
(assigned to Brandeis University)

Addresses rotation and translation invariant recognition.

In-Place Differential File Compression

United States patent number: 7,079,051
INVENTORS: James A. Storer and Dana Shapira
FILED: March 18, 2004
GRANTED: July 18, 2006
(23 claims, 6 of them independent)

Addresses in-place differential file compression methods that can be used in software update and backup systems.

Method and Apparatus for Data Compression

United States patent number: 5,379,036
INVENTOR: James A. Storer
FILED: April 1, 1992
GRANTED: January 1, 1995
(23 claims, 3 of them independent)

Addresses high speed parallel algorithms and hardware for data compression.

System for Dynamically Compressing and Decompressing Electronic Data

United States patent number: 4,876,541
INVENTOR: James A. Storer
FILED: October 15, 1987
GRANTED: October 24, 1989
(55 claims, 5 of them independent)

Addresses dictionary based adaptive data compression.

Papers

"Compression-Based Tools for Navigation with and Image Database", *Algorithms* 5, 2012, 1-17
     (coauthored with A. DiLillo, A. Daptardar, K. Thomas, G. Motta)

"Edit Distance With Block Deletions", *Algorithms* 4, 2011, 40-60 (coauthored with D. Shapira).

"Applications of Compression to Content Based Image Retrieval and Object Recognition",
     *Proceedings International Conference On Data Compression, Communication, and
     Processing* (CPP 2011), Palinuro, Italy, 179 - 189 (coauthored with Antonella Di Lillo,
     Ajay Daptardar, Giovanni Motta, and Kevin Thomas)

"A Rotation And Scale Invariant Descriptor For Shape Recognition", *Proceedings International
     Conference On Image Processing* (ICIP), Hong Kong, 2010, MA-L9:1, 257-260
     (coauthored with A. DiLillo and G. Motta).

"Shape Recognition, With Applications To A Passive Assistant", Proceedings *PETRA -
     PErvasive Technologies Related to Assistive Environments*, Samos, Greece, June 23-25;
     to appear *ACM International Conference Proceedings Series* (coauthored with A.
     DiLillo, G. Mota, and K. Thomas), 2010.

"Shape Recognition Using Vector Quantization", *Proceedings Data Compression Conference*,
     IEEE Computer Society Press, March 2010, 484-493 (coauthroed with A. Di Lillo and
     G. Motta).

"Network Aware Compression Based Rate Control for Printing Systems", Proceedings 10th
     International Symposium on Pervasive Systems (ISPAN 2009), Kaohsiung, Taiwan,
     December 2009, 123-128 (coauthored with Chih-Yu Tang).

"VQ Based Image Retrieval Using Color and Position Features", *Proceedings Data Compression
     Conference*, IEEE Computer Society Press, March 2008, 432-441 (coauthored with A.
     Daptardar).

"Multiresolution Rotation-Invariant Texture Classification Using Feature Extraction in the
     Frequency Domain and Vector Quantization", *Proceedings Data Compression
     Conference*, IEEE Computer Society Press, March 2008, 452-461 (coauthored with A.
     DiLillo and G. Motta).

"Edit Distance with Move Operations", *Journal of Discrete Algorithms* 5:2, June 2007, 380-392
     (coauthored with D. Shapira).

"Texture Classification Based on Discriminative Feature Extracted in the Frequency Domain",
     Proceedings IEEE International Conference on Image Processing (ICIP), September
     2007, II.53-II.56 (coauthored with A. DiLillo and G. Motta).

"Supervised Segmentation Based on Texture Signature Extracted in the Frequency Domain", *Third Iberian Conference on Pattern Recognition and Image Analysis* (IbPRIA), June 2007 (coauthored with A. DiLillo and G. Motta).

"Texture Classification Using VQ with Feature Extraction Based on Transforms Motivated by the Human Visual System", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 392, 2007 (coauthored with A. DiLillo and G. Motta).

"Reduced Complexity Content-Based Image Retrieval using Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 342-351, 2006 (coauthored with A. H. Daptardar).

"In-Place Differential File Compression", *Computer Journal* 48:6, 677-691, November 2005 (coauthored with D. Shapira).

"Compression of Hyper/Ultra-Spectral Data", *Proceedings of SPIE, Optics and Photonics, Satellite Data Compression, Communication and Archiving*, Jul. 2005, Vol. 5889, pp. 588908-1--588908-10 (coauthored with G. Motta and F. Rizzo).

"Content-Based Image Retrieval Via Vector Quantization", In *Advances in Visual Computing - Springer Lecture Notes in Computer Science* 3804/2005 (ISBN 3-540-30750-8), 502-509; also appeared in *International Symposium on Visual Computing*, December 5-7, 2005 (coauthored with A. Daptardar).

"Low Complexity Lossless Compression of Hyperspectral Imagery via Linear Prediction", *IEEE Signal Processing Letters* 12:2, 138-141, 2005 (coauthored with F. Rizzo, B. Carpentieri, and G. Motta).

"Overlap and Channel Errors in Adaptive Vector Quantization for Image Coding", *Information Sciences* 171:1-3, 125-143, 2005 (coauthored with B. Carpentieri and F. Rizzo).

"Compression of Hyperspectral Imagery", *Proceedings International Conference on E-Business and Telecommunications* (ICETE), Sebutal, Portugal, 2004; an extended version of this paper is a chapter in the book *E-Business and Telecommunication Networks*, Edited by J. Ascenso, L. Vasiu, C. Belo, and M. Saramago, Kluwer / Springer, 317-324 (coauthored with B. Carpentieri, G. Motta, and F. Rizzo).

"Real-Time Software Compression and Classification of Hyperspectral Images", *Proceedings 11th SPIE International Symposium on Remote Sensing Europe*, X. L. Bruzzone, Ed., Maspalomas, Gran Canaria, Spain, Sept. 13-17, 2004, Vol. 5573, 182-192, (coauthored with B. Carpentieri, G. Motta, and F. Rizzo).

"Lossless Compression of Hyperspectral Imagery: A Real Time Approach", *Proceedings 11th SPIE International Symposium on Remote Sensing Europe*, X. L. Bruzzone, Ed., Maspalomas, Gran Canaria, Spain, Sept. 13-17, 2004, Vol. 5573, 262-272, (coauthored with B. Carpentieri, G. Motta, and F. Rizzo).

"High Performance Compression of Hyperspectral Imagery with Reduced Search Complexity in the Compressed Domain", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 2004, 479-488 (coauthored with B. Carpentieri, G. Motta and F. Rizzo).

"In-Place Differential File Compression of Non-Aligned Files With Applications to File Distribution and Backups", *Proceedings Data Compression Conference* (DCC), IEEE Computer Society Press, 2004, 82-91 (coauthored with D. Shapira).

"Report of the National Science Foundation Workshop on Information Theory and Computer Science Interface", produced by workshop of 20 invited participants (Chicago, Il. 2003), report completed and submitted to the NSF in November 2004.

"Finding Non-Overlapping Common Substrings in Linear Time", *Proceedings Symposium on String Processing and Information Retrieval* (SPIRE), 2003, *Lecture Notes on Computer Science*, Volume 2857/2003 ISBN: 3-540-20177-7, Springer-Verlag, 369-377 (coauthored with M. Meyerovich and D. Shapira).

"In-Place Differential File Compression", *Proceedings Data Compression Conference* (DCC), IEEE Computer Society Press, 263-272, 2003 (coauthored with D. Shapira).

"Compression of Hyperspectral Imagery", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 333-342, 2003 (coauthored with G. Motta and F. Rizzo).

"Partitioned Vector Quantization: Application to Lossless Compression of Hyperspectral Images", *Proceedings International Conference on Acoustics, Speech, and Signal Processing* (ICASSP), IMSP-P2.2-III, 241-244, 2003; also presented at *IEEE International Conference on Multimedia and Expo* (ICME2003), 2003, 553-556 (coauthored with G. Motta and F. Rizzo).

"Generalized Edit Distance with Move Operations", *Thirteenth Annual Symposium on Combinatorial Pattern Matching* (CPM), 85-98, 2002 (coauthored with D. Shapira).

"A Lossless Data Compression Algorithm for Electro-Cardiograms", Technical Report, Computer Science Department, Brandeis University (coauthored with G. Motta and M. Hosang); see also senior honors thesis of M. Hosang.

"LZ-Based Image Compression", *Information Sciences* 135, 107-122, 2001 (coauthored with F. Rizzo and B. Carpentieri).

"Optimal Encoding of Non-Stationary Sources", *Information Sciences*, 87-105, 2001 (coauthored with J. Reif).

"Overlap in Adaptive Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 401-410, 2001 (coauthored with F. Rizzo).

"Lossless Image Coding via Adaptive Linear Prediction and Classification", *Proceedings of the IEEE 88:11*, 1790-1796 (coauthored with G. Motta and B. Carpentieri), November 2000.

"Optimal Frame Skipping for H263+ Video Encoding", *Proceedings 11th Annual International Conference on Signal Processing Applications and Technology*, Dallas, TX October 2000, 373-377 (coauthored with G. Motta).

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"Error Resilient Dictionary Based Compression", *Proceedings of the IEEE 88:11*, 1713-1721, 2000.

"Improving Scene Cut Quality for Real-Time Video Decoding", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 470-479, 2000 (coauthored with G. Motta and B. Carpentieri).

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"Experiments with Single-Pass Adaptive Vector Quantization", *Proceedings Data Compression Conference*, IEEE Computer Society Press, 546, 1999 (coauthored with F. Rizzo and B. Carpentieri).

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"The Prevention of Error Propagation in Dictionary Compression with Update and Deletion", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 1998, 199-208.

"Optimal Lossless Compression of a Class of Dynamic Sources", *Proceedings IEEE Data Compression Conference*, 1998, 501-510 (coauthored with J. Reif).

"Error Resilient Data Compression with Adaptive Deletion", in *Compression and Complexity of Sequences,* IEEE Press, 285-294, 1998.

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"Generalized Node Splitting and Bi-Level Image Compression", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 443, 1997 (co-authored with H. Helfgott).

"Selective Resolution for Surveillance Video Compression", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 468, 1997 (co-authored with I. Schiller, C. Chuang, and S. King).

"A Video Coder Based on Split-Merge Displacement Estimation", *Journal of Visual Communication and Visual Representation 7:2*, 137-143, 1996; an abstract of this paper appeared in *Proceedings DCC 1993*, 492 (co-authored with B. Carpentieri).

"On-Line versus Off-Line Computation in Dynamic Text Compression", *Information Processing Letters 59*, 169-174, 1996 (co-authored with S. DeAgostino).

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"High Performance Adaptive Data Compression", *Proceedings DAGS: Electronic Publishing and the Information Superhighway*, Boston, MA, 29-38, 1995 (co-authored with C. Constantinescu and B. Carpentieri).

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"Near Optimal Compression with Respect to a Static Dictionary on a Practical Massively Parallel Architecture", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 172-181, 1995 (co-authored with D. Belinskaya and S. DeAgostino).

"Application of Single-Pass Adaptive VQ to BiLevel Images", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 423, 1995 (co-authored with C. Constantinescu).

"Classification of Objects in a Video Sequence", *Proceedings SPIE Symposium on Electronic Imaging*, San Jose, CA, 1995 (co-authored with B. Carpentieri).

"Optimal Inter-Frame Alignment for Video Compression", *International Journal of Foundations of Computer Science 5:2*, 65-177, 1994 (co-authored with B. Carpentieri).

"Improved Techniques for Single-Pass Vector Quantization", *Proceedings of the IEEE 82:6*, 933-939, 1994; an extended abstract of this paper appeared in the *Proceedings DCC 1994,* 410-419 (co-authored with C. Constantinescu).

"Split-Merge Video Displacement Estimation", *Proceedings of the IEEE 82:6*, 940-947, 1994; an extended abstract of this paper appeared as "A Split and Merge Parallel Block-Matching Algorithm for Displacement Estimation", *Proceedings DCC 1992,* 239-248 (co-authored with B. Carpentieri).

"On-Line Adaptive Vector Quantization with Variable Size Codebook Entries", *Information Processing and Management 30:6*, 745-758, 1994; a preliminary version of this paper appeared as "On-Line Adaptive Vector Quantization with Variable Size Vectors", *Proceedings DCC 1993*, 32-41 (co-authored with C. Constantinescu).

"Design and Performance of Tree-Structured Vector Quantizers", *Information Processing and Management 30:6,* 1994, 851-862; a preliminary version of this paper appeared in the *Proceedings DCC 1993*, 292-301 (co-authored with J. Lin).

"Shortest Paths in the Plane with Polygonal Obstacles", *Journal of the ACM 41:5,* 982-1012, 1994 (co-authored with J. Reif).

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"Image Compression", Encyclopedia of Computer Science and Technology, Volume 29, 231-256, 1994 (co-authored with J. Lin).

"On the Design and Implementation of a Lossless Data Compression and Decompression Chip", *IEEE Journal of Solid-State Circuits*, 948-953, 1993 (co-authored with D. M. Royals, T. Markas, N. Kanopoulos, and J. H. Reif).

"On Parallel Implementations and Experimentations of Lossless Data Compression Algorithms", *Proceedings Picture Coding Symposium*, Lausanne, Switzerland, Section 5.3, March 1993; a preliminary version of this paper appears in *Proceedings DCC 1992*, (co-authored with J. Reif and T. Markas).

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"Split Merge Displacement Estimated Video Compression", *Proceedings 7th International Conference on Image Analysis and Processing*, Bari, Italy, September, 1993 (co-authored with B. Carpentieri).

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"Adaptive Lossless Data Compression over a Noisy Channel", *Methods in Communication, Security, and Computer Science*, Springer-Verlag, 104-117, 1993; a preliminary version of this paper appeared in *Proceedings Sequences 91*, Positano, Italy 1991 (co-authored with J. Reif).

"Improving Search for Tree-Structured Vector Quantization", *Proceedings Data Compression Conference,* IEEE Computer Society Press, 339-348, 1992 (co-authored with J. Lin).

"Parallel Algorithms for Optimal Compression Using Dictionaries with the Prefix Property", *Proceedings DCC '92,* 152-61 (co-authored with S. DeAgostino).

"Parallel Algorithms for Data Compression", invited presentation, 1992 ALGOFEST symposium, Bristol, RI.

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"Massively Parallel Systolic Algorithms for Real-Time Dictionary-Based Text Compression", *Image and Text Compression*, Kluwer Academic Press, 159-178, 1992.

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